Space Weather Technical Forecast

Issued on Saturday 12 October 2024 at 01:10 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Waning CME effects over the next 24 hours. Slight chance of G1 at first. R1s likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity at GOES16 and 18 has been Moderate, with the peak flare in the period an M2.2 at 11/1633UTC from AR3854 or AR3852.

There are now six numbered sunspots on the visible disc. There are three main areas of the disc that currently harbour sunspot regions: the northwest, which retains AR3848 as a Dho/Beta, with some consolidation evident in recent hours its its previously well-dispersed trailing spots and pores. West of centre disc, AR3849 showed fading of minor northern spots as further ones developed to its south - these may yet be re-designated as a small new bipolar region (labelled NEW here). Finally, the southeast disc kept its two main groups, AR3854 and AR3852, which appeared relatively stable in recent hours.

No Earth-directed CMEs have been observed over the past 24 hours.

Solar Wind / Geomagnetic Activity: This 24-hour period showed strong CME influence from the X1.8 09 October CME which hit Earth-based magnetometers at 10/1515UTC. A gradual waning trend was seen the second half of 11 October.

The solar wind speed, recorded at L1 by DSCOVR and ACE was strong, near 700km/s, for the first half of the UTC day, but rose to very strong levels at times, peaking at 810km/s just before 11/1200UTC. A gradual waning trend then ensued during the second half of the day, with speeds around 650 km/s by the end of the period. Density was initially around Average, but peaked at above average levels of 17ppcc at 11/0947UTC, before declining to mainly below average levels from 11/1200UTC.

The IMF was initially very strong at 39nT but declined to moderate levels of around 10nt from around 11/1200UTC. Bz was initially nearly perfectly anti-aligned at around -39nT. This strong anti-alignment then continued for the first half of the reporting period, very gradually waning in intensity. Bz then became mainly weakly positive from around 11/1400UTC. The phi angle was mainly towards (negative).

Resulting geomagnetic activity was very disturbed for the first of the day, with Strong-Severe storms (Kp7-Kp8) between 11/0000-1200UTC. Activity then decreased through the second half of

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the day to become unsettled (Kp3) by 11/2100UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 has returned to background levels. 10MeV protons started the period at 17pfu (S1) and have since shown a gradual downward trend, falling below S1 levels from 11/0645UTC.

High energy electron flux (greater than 2MeV) observed by GOES16 were largely at Normal Background at GEO, but did show some enhancement to moderate levels during the evening.

The associated 24-hour fluence was well below the Active threshold. The 24-hour fluence values have been restored, with a 12/0000UTC value of 5.2e6.

Four-Day Space Weather Forecast Summary

Solar Activity: R1s remain Likely through this four-day period given developments on the disc, their complexity, and perhaps two arrivals over the eastern limb over the next 24 hours. The significant flare risk level is therefore almost flat - after an initial slightly higher risk from Ex-AR3842 should it produce any very large events from near 110W.

Solar Wind / Geomagnetic Activity: The CME from the 09 October X1.8 flare and filament eruption is continuing to affect Earth, but its intensity continues to wane. This is the only CME in the forecast. Either of a pair of potential coronal hole fast winds may affect Earth late day 2 (Sunday 13 October), although confidence in their effects being felt is low.

There is a slight chance of G1 Minor (Kp 5) intervals early day 1 (Saturday 12 October), but activity continuing to wane further through the day to predominately Quiet-Active levels (Kp1-4) with a low confidence Slight Chance of G1 should either of the coronal holes' fast winds impinge on Earth over the next few days.

Energetic Particles / Solar Radiation: The risk of S1/Minor storms should return to the residual risk for the disc by day 3 (Sunday 13 October). This accounts for the initial slightly raised levels and the presence of Ex-AR3842 over the limb. East limb arrivals do not feature.

High energy electron flux is now at Normal Background. A rising Slight Chance of recovery of fluence may occur later in the UTC weekend, before any possible fast winds arrive, although the effect of these should be limited.

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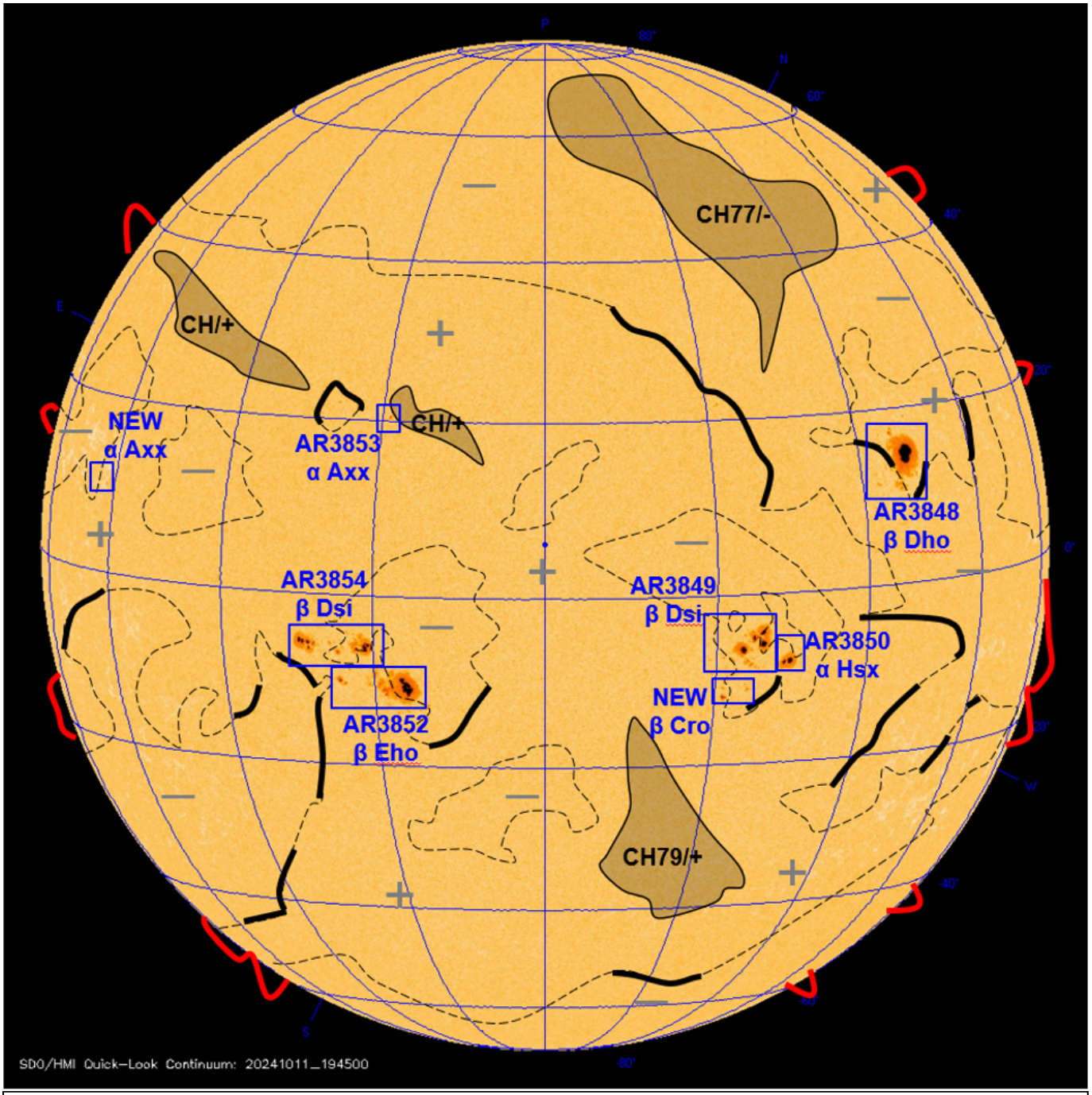
Figure 1: MOSWOC solar synoptic map, validity time 11/1945UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME from the 09 October X1.8 flare and filament eruption is continuing to affect Earth, but its intensity continues to wane. This is the only CME in the forecast.

Either of a pair of potential coronal hole fast winds may affect Earth late day 2 (Sunday 13 October), although confidence in their effects being felt is low. Earth may potentially 'thread the needle' between these northern and southern hemisphere features. CH79/+ in the south has retreated pole-ward compared to last rotation and appears more tenuous, and therefore any connection with Earth is likely to be weak, with any fast wind approaching 450km/s. Alternatively, CH77/- also stands a chance of connecting around the same time, however its apparent greater intensity (versus CH79/+ from e.g. AIA211 imagery) will be mitigated against by its unfavoured polarity.

There is a slight chance of G1 Minor (Kp 5) intervals early day 1 (Saturday 12 October), but activity continuing to wane further through the day to predominately Quiet-Active levels (Kp1-4) with a low confidence Slight Chance of G1 should either of the coronal holes' fast winds impinge on Earth from late Day 2 (Sunday 13 October).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	20	5	5	5
Strong	**G3**	Yes	1	1	1	0
Severe	**G4**	Yes	1	1	1	0
Extreme	**G5**	No	1	1	1	0

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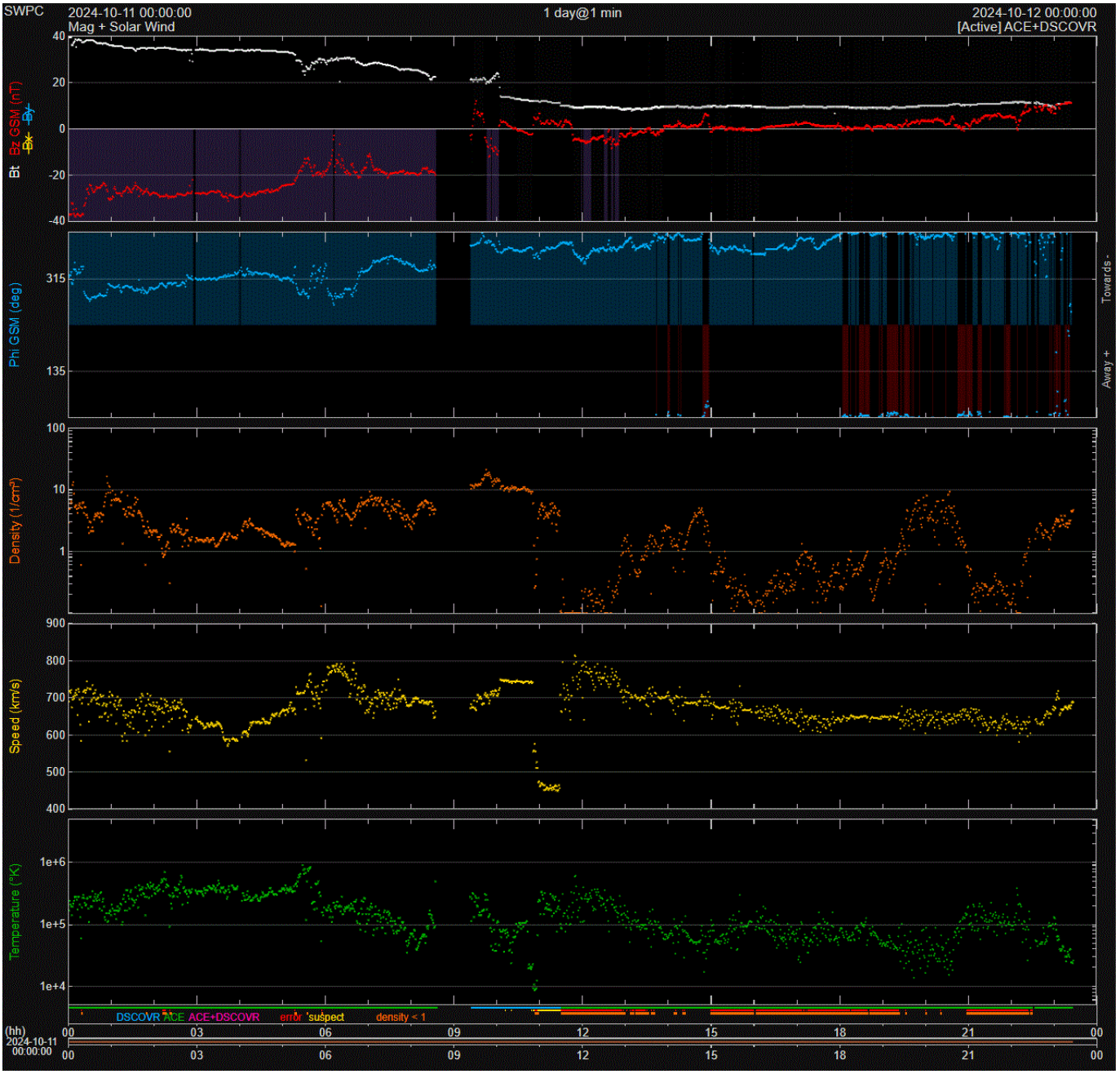
Figure 2: NOAA SWPC metrical for the past 24 hours



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Radio Blackouts - X-Ray Flares

The recent very active sunspot region Ex-AR3842 is now on the far side, however no further front-sided regions depart over the western limb in the four days. Going some way towards potentially mitigating against the loss of Ex-AR3842, the Carrington locations for two returning regions are due over the eastern solar horizon inside 24 hours time.

Added to these populating/depopulating factors is the consideration of a recently emerging sunspot region in the eastern hemisphere in the form of AR3854, which continues to show some slight growth and is one to watch as it approaches centre-disc (for CMEs).

All considered, the risks of further significant flares are now lower than in the recent past (when Ex-AR3842 was present as a front-sided feature). The risk sources for further flares are now much more well-spread across the disc: AR3848 has the history of such activity in the northwest; AR3849 is decaying (but is in a prone location for CMEs); and the southeastern AR3854 has been showing minor growth.

The significant flare risk level is therefore almost flat - after an initial slightly higher risk from Ex-AR3842 should it produce any very large events from near 110W.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	65	60	60	60
Very Active	**R3-R5 (X Class)**	No	15	10	10	10

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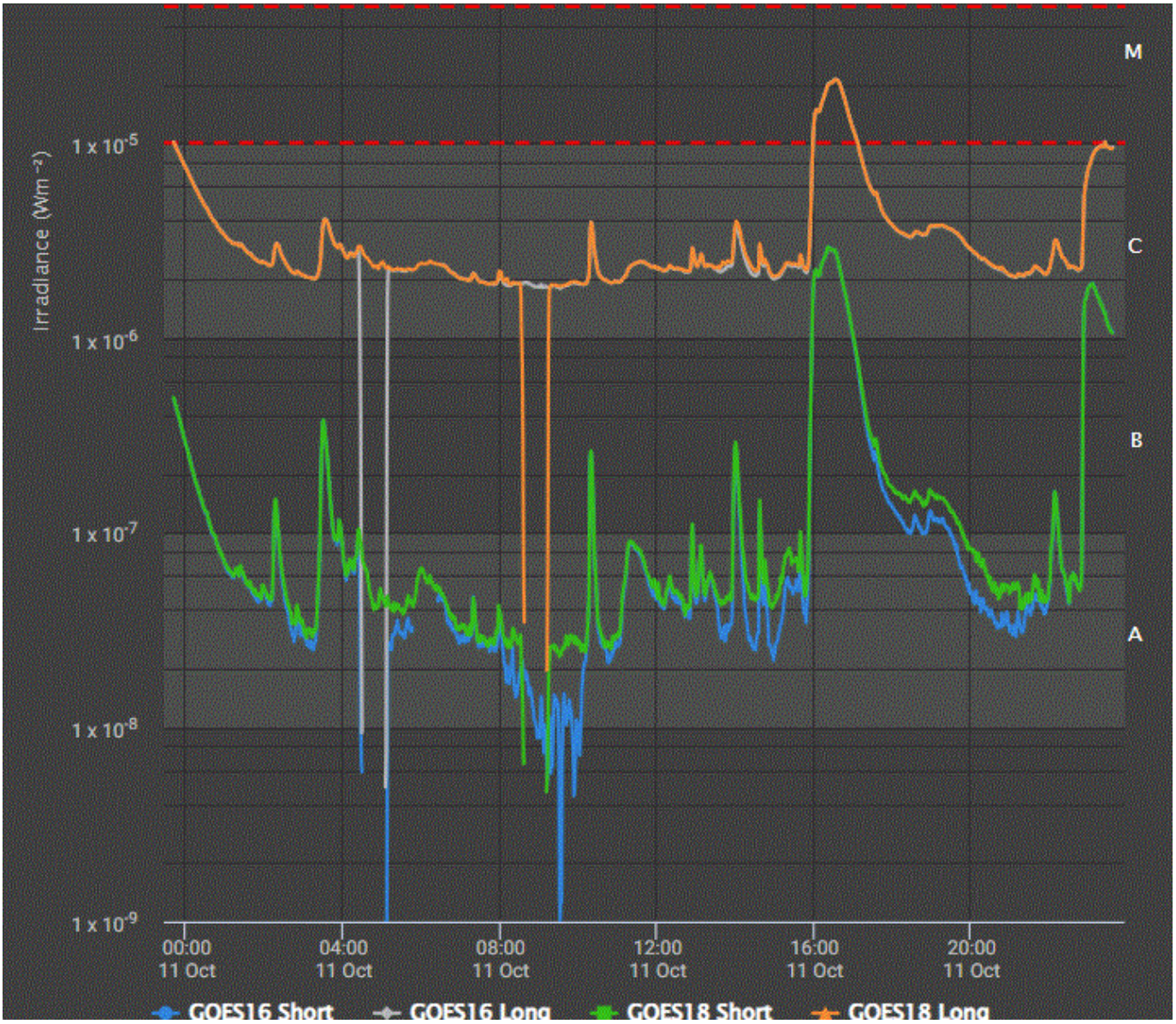
Figure 3: 24 hour X-ray flux



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Solar Radiation Storms (High Energy Protons)

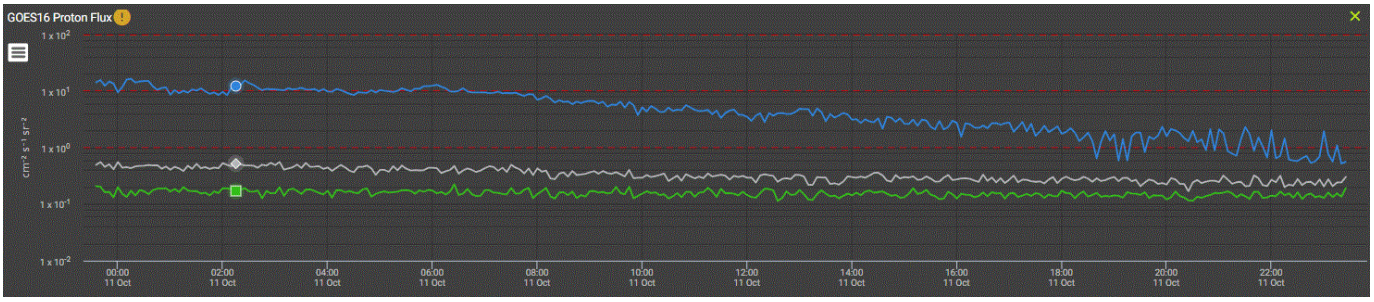
High energy proton flux at GOES18 has returned to background in the wake of the combined X1.8 and filament eruption on 09 Oct from the vicinity of AR3848 in the northwestern quadrant.

10MeV protons have now returned below the S1 threshold after initial enhancement but the risks of S-scale remain higher than raw values due to the ongoing slightly raised levels. Regarding potential new enhancements, AR3848 remains on the disc, and account must still be taken of AR3842's gradual retreat around the far side near 110W.

Overall, there remains a Chance of a return to S1 at first, relaxing to the residual risk for the current disc later in the coming UTC weekend as the counts in the near-Earth environment subside and Ex-AR3842 rotates sufficiently far round as to no longer pose a significant threat.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	25	20	15	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton trace at L1 (GOES 18).



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) is currently between Normal Background and moderate levels after the 09 October CME arrival during the second half of 10 October compressed the outer Van Allen belt beyond GEO. These low counts at GEO are likely to continue on the 12 October. A gradual recovery to diurnal Moderate or High is possible through 13 October before any fast wind from CH79/+ (or perhaps CH77/-) takes effect, should either arrive.

There is a rising Slight Chance of Active 24-hour integrated fluence, probably peaking later in the UTC weekend given the forecast described above. MOSWOC REFM is not considered useful in this situation given the utter dominance of a large CME early in its evolution, and then the expected dissimilarity of the coronal holes' fast winds on this pass.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	20	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: Electron flux observations

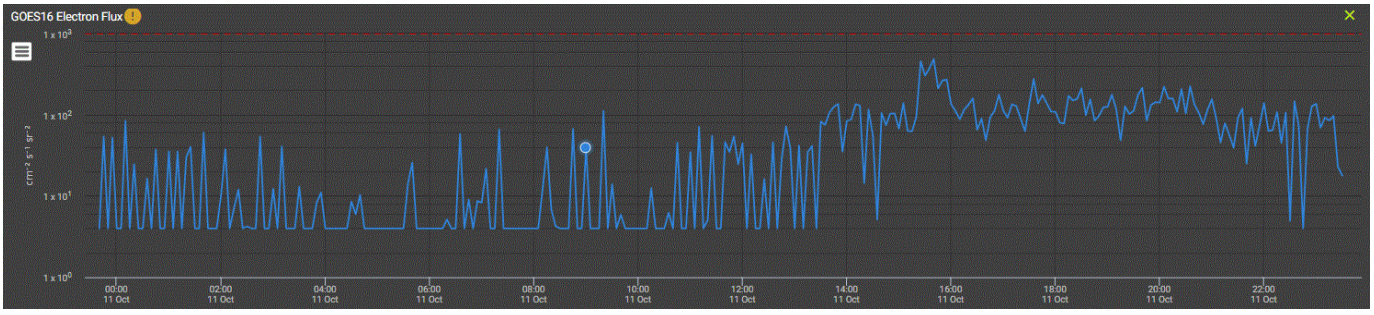

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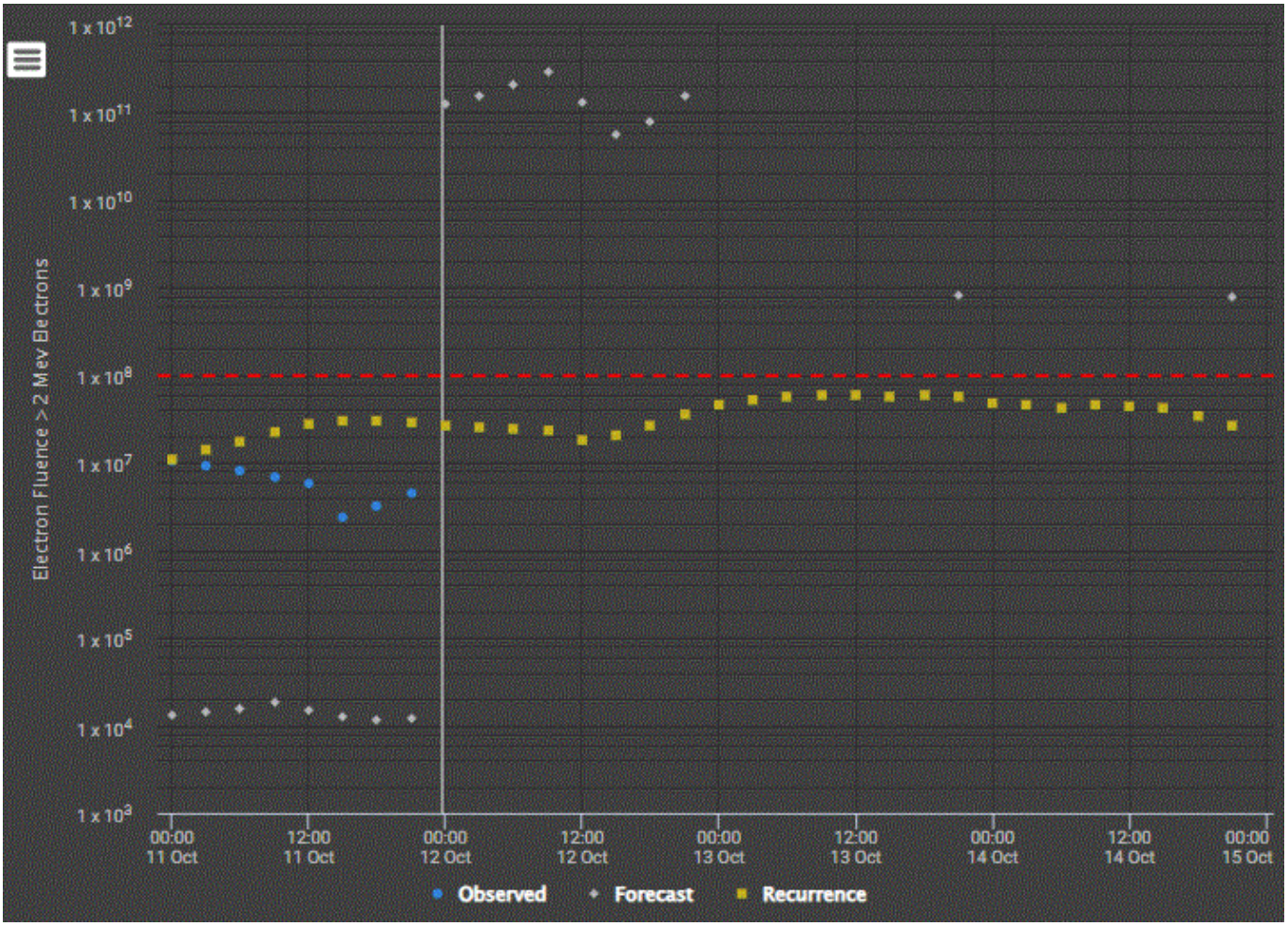
Figure 6: MOSWOC REFM fluence forecast/recurrence



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